

CLAIMS

What is claimed is:

- 1 1. A network switch having a hybrid switch architecture,
2 comprising:
3 at least two shared-memory switch fabrics, each shared-memory switch
4 fabric being configured to store and retrieve packets; and
5 at least two crossbar switch fabrics, each crossbar switch fabric being
6 coupled to each of the shared-memory switch fabrics and configured to
7 distribute and re-collect packets to and from each of the shared-memory switch
8 fabrics.
- 1 2. The network switch of claim 1, wherein each shared-memory
2 switch fabric is a $N \times N$ shared-memory switch fabric, N being an integer greater
3 than 1, and wherein each shared-memory switch fabric includes N inputs for
4 receiving packets and N outputs for sending packets on N channels and
5 wherein at least one channel is coupled to each crossbar switch fabric.
- 1 3. The network switch of claim 2, wherein each crossbar switch
2 fabric is a $n \times m$ crossbar switch fabric, n being an integer and m being an integer
3 greater than one, and wherein each $n \times m$ crossbar switch fabric is coupled to n

4 ports for receiving and transmitting packets from and to network ports and m
5 channels for distributing and re-collecting packets to and from the NxN
6 shared-memory shared-memory switch fabrics, and wherein at least one of the
7 m channels is coupled with each NxN shared-memory switch fabric.

1 4. The network switch of claim 3, wherein m is an integer multiple of
2 a total number of NxN shared-memory switch fabrics.

1 5. The network switch of claim 4, comprising:
2 a first and second 48x48 shared memory switch fabrics; and
3 12 8x8 crossbar switch fabrics, each 8x8 crossbar switch fabric is coupled
4 with 4 channels of the first and second 48x48 shared-memory switch fabrics.

1 6. The network switch of claim 3, wherein the aggregate data rate on
2 the m channels is greater than the aggregate data rate on the n ports for the
3 nxm crossbar switch fabrics.

1 7. The network switch of claim 5, wherein the NxN connectivity for
2 the shared-memory switch fabrics is greater than the nxm connectivity of the
3 crossbar switch fabrics.

1 8. The network switch of claim 1, wherein each crossbar switch
2 fabric is a $1 \times m$ crossbar switch fabric, m being an integer greater than one, and
3 wherein each $1 \times m$ crossbar switch fabric includes 1 port for receiving and
4 transmitting packets from and to a single network port and m channels for
5 distributing and re-collecting packets to and from the shared-memory switch
6 fabrics.

1 9. The network switch of claim 8, wherein m is an integer multiple of
2 a total number of shared-memory switch fabrics.

1 10. The network switch of claim 9, comprising:
2 a first and second 48×48 shared-memory switch fabrics; and
3 12 1×8 crossbar switch fabrics, each 1×8 crossbar switch fabric is coupled
4 with 4 channels of the first and second 48×48 shared-memory switch fabrics.

1 11. The network switch of claim 1, further comprising:
2 a port controller coupled to each of the crossbar switch fabrics and
3 configured to retrieve packets from at least one network port and to forward
4 packets to the crossbar switch fabrics and configured to receive packets from
5 the crossbar switch fabrics and to forward packets to a destination network
6 component via the at least one network port; and

7 a shared buffer memory coupled to each of the shared-memory switch
8 fabrics configured to store temporarily packets distributed from the crossbar
9 switch fabrics.

1 12. The network switch of claim 11, further comprising:
2 a notify ring coupling each port controller, the notify ring configured to
3 transfer forwarding information to each port controller, and wherein the
4 forwarding information is used to request packets from the shared-memory
5 switch fabrics by a port controller.

1 13. The network switch of claim 1, wherein each crossbar switch
2 fabric is configured to distribute packets directly, randomly, in a round robin,
3 or some other selective manner on an ingress path to the shared-memory
4 switch fabrics such that the distributed packets are stored in the shared buffer
5 memory.

1 14. The network switch of claim 13, wherein each shared-memory
2 switch fabric is configured to store and retrieve the distributed packets from the
3 crossbar switch fabrics in the shared buffer memory.

1 15. The network switch of claim 12, wherein each shared-memory
2 switch fabric is also configured to send a packet buffer number indicating
3 where a packet is stored in a shared buffer memory.

1 16. The network switch of claim 15, wherein each port controller is
2 also configured to generate the forwarding information based on the packet
3 buffer number and switch instance sent from each shared-memory switch
4 fabric.

1 17. The network switch of claim 16, wherein each port controller is
2 configured to request packets from each of the shared-memory switch fabrics
3 using the forwarding information.

1 18. The network switch of claim 15, wherein packets are requested
2 from each of the shared-memory switch fabrics based on an availability of a
3 channel, and wherein the packets are capable of being requested in an order
4 different from an order the packets were received by the crossbar switch
5 fabrics.

1 19. The network switch of claim 18, wherein each crossbar switch on
2 an egress path re-collects the requested packets and transmits the packets on

3 egress ports in the order the requested packets were received by the crossbar
4 switch on an ingress path before distribution.

1 20. The network switch of claim 18, wherein re-collected packets are
2 stored in egress buffers, the re-collected packets are capable of being re-ordered
3 in the egress buffers.

1 21. The network switch of claim 20, wherein each port controller
2 includes:
3 an egress request queue storing requests to re-collect packets from the
4 shared-memory switch fabrics, and wherein the requests are serviced based on
5 an availability of a channel.

1 22. The network switch of claim 20, wherein each crossbar switch
2 fabric further includes:
3 an ingress switching unit configured to receive packets and forward the
4 received packets to channels coupled with the shared-memory switch fabrics;
5 and
6 an egress switching unit configured to receive requested packets from
7 the shared-memory switch fabrics and forward the requested packets to a port
8 controller.

1 23. The network switch of claim 1, wherein the packets are data
2 packets for an Ethernet network.

1 24. The network switch of claim 1, wherein the packets are data cells
2 for an asynchronous transfer mode (ATM) network or for storage area network
3 frames.

1 25. A network switch having a hybrid switch architecture,
2 comprising:
3 a plurality of NxN shared-memory switch fabrics, each NxN shared-
4 memory switch being configured to store and retrieve packets and wherein N
5 in an integer greater than 1; and
6 at least two nxm crossbar switch fabrics, each nxm crossbar switch
7 fabrics coupled with each NxN shared-memory switch fabric and configured to
8 distribute and re-collect packets from each NxN shared-memory switch fabric
9 and wherein n is an integer and m is an integer multiple of a total number of
10 the plurality of NxN shared-memory switch fabrics.

1 26. The network switch of claim 25, wherein the total number of the
2 plurality of NxN shared-memory switch fabrics is at least two.

1 27. The network switch of claim 25, wherein each crossbar switch
2 fabric is coupled with n ports for receiving packets from a source network
3 component on an ingress path and for transmitting packets to a destination
4 network component on an egress path and m channels for distributing and re-
5 collecting packets to and from the plurality of NxN shared-memory switch
6 fabrics.

1 28. The network switch of claim 27, wherein each NxN shared-
2 memory switch fabric is coupled to one of the m channels.

1 29. A method of using a network switch having a hybrid switch
2 architecture, the method comprising:
3 distributing packets received by an ingress crossbar switch fabric to at
4 least two shared-memory switch fabrics; and
5 storing the distributed packets from the ingress crossbar switch fabric in
6 a shared buffer memory associated with each shared-memory switch fabric.

1 30. The method of claim 29, further comprising:
2 removing header or control information from received packets before
3 distribution.

1 31. The method of claim 29, wherein distributing packets distributes
2 packets directly, randomly, in a round robin, or some other selective manner to
3 the shared-memory switch fabrics.

1 32. The method of claim 29, further comprising:
2 sending a packet buffer number and a switch instance for each packet
3 stored by each shared-memory switch fabric to an ingress port controller, the
4 packet buffer number including information indicating where the packet is
5 stored in the shared buffer memory and the switch instance including
6 information which shared-memory switch fabric stored the packet.

1 33. The method of claim 32, further comprising:
2 generating forwarding information using the packet buffer number and
3 switch instance; and
4 sending the forwarding information to an egress port controller via a
5 notify ring.

1 34. The method of claim 30, further comprising:
2 requesting packets from the shared-memory switch fabrics by an egress
3 port controller using the forwarding information from the ingress port
4 controller; and

5 re-collecting the requested packets from the shared-memory switch
6 fabrics by the egress port controller.

1 35. The method of claim 34, further comprising:
2 retrieving the requested packets from the shared buffer memory by the
3 shared-memory switch fabrics; and
4 transmitting the packets to a destination network component in an order
5 the packets were received by the ingress port controller.

1 36. The method of claim 30, further comprising:
2 requesting packets from the shared-memory switch fabrics by an egress
3 port controller based on an availability of a channel regardless of an order the
4 packets were received by an ingress port controller; and
5 re-collecting the requested packets by the egress port controller; and
6 re-ordering the re-collected packets such that packets are to be
7 transmitted to a destination network component in an order the packets were
8 received by the ingress port controller.

1 37. A network switch having a hybrid switch architecture comprising:
2 at least two shared-memory switch fabrics;
3 a first crossbar switch fabric configured to distribute received packets to
4 the at least two shared-memory switch fabrics;

